TECHNOLOGY NEEDS/OPPORTUNITIES STATEMENT

UNDERSTAND, QUANTIFY, AND DEVELOP DESCRIPTIONS OF TRANSPORT AND TRANSFORMATION OF GROUNDWATER-DERIVED CONTAMINANTS OF CONCERN IN THE RIVER

Identification No.: RL-SS38
Date: September 2001

Program: Environmental Restoration
OPS Office/Site: Richland Operations Office/Hanford Site
Operable Unit(s): Broad need potentially applicable to multiple operable units.
PBS No.: RL-SS04 (RL-VZ01)
Waste Stream: Groundwater (Disposition Map Designation: ER-10 [technical risk score 5] and ER-18 [technical risk score 5])
TSD Title: N/A
Waste Management Unit (if applicable): N/A
Facility: N/A

***Priority Rating*:**

This entry addresses the "Accelerated Cleanup: Paths to Closure (ACPC)" priority:

X 1. Critical to the success of the ACPC
___ 2. Provides substantial benefit to ACPC projects (e.g., moderate to high lifecycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays)
___ 3. Provides opportunities for significant, but lower cost savings or risk reduction, and may reduce uncertainty in ACPC project success.

***Need Title*:** Understand, Quantify, and Develop Descriptions of Transport and Transformation of Groundwater-Derived Contaminants of Concern in the River

Need/Opportunity Category: Technology Need.

***Need Description*:** This need addresses specific technical gaps identified in the scope of the Groundwater/Vadose Zone Integration Project (Integration Project) at the Hanford Site and is written as an "integrated" need. The Integration Project is focused on providing the scientific and technical basis to ensure that Hanford Site decisions, including decisions related to long-term stewardship, are defensible and possess an integrated perspective for the protection of water resources, the Columbia River, river-dependent life, and users of the Columbia River resources. As such, this "integrated" need has both applied S&T components that are interrelated in addressing the specified technical gap. Individual efforts applied to resolve the technical gaps described in this need may address all or part of the components identified for this need. Where a specific technology need can be defined separately from an "integrated" need, a specific technology need statement has been written and is included elsewhere in the Hanford Site STCG

Subsurface Contamination Needs (e.g., RL-SS25: Improved, Cost-Effective Methods for Subsurface Access to Support Characterization and Remediation).

The primary technical gap associated with reactions and interactions between contaminants and sediments in the river and bank-storage region involves insufficient understanding of these processes at Hanford in terms of quantifying and parameterizing the processes for use in the development and application fate and transport. An understanding of these fundamental processes is needed to predict the fate and transport of contaminants into and through the river. Specific issues that need to be addressed to resolve this technical gap include the following.

- The chemical, physical, and biological reactions and transformations that occur within the bank storage region (i.e., zone of interaction between the near river aquifer and vadose zone sediments that are affected by river stage fluctuations) can greatly affect the form, concentration, and spatial/temporal distribution of contaminants moving within the surface water system. Bank storage clearly delays downstream transport of water-borne contaminants, and may prolong aquatic biological exposures in the nearshore environments. In addition, bank storage may enhance exposures of terrestrial species to contaminants not otherwise found in the groundwater at these regions (Brandt et al. 1993).

- Physics-based transport models (hydraulic, sediment, contaminant) are needed to represent the movement of contaminants into and through the river environment.

- Numerical models are needed that incorporate the chemical, physical, and biological reactions and interactions in the river for contaminants in aqueous phase (dissolved species), colloid phase, and sediment phase into the physics-based transport models based on hydraulics and sediment transport.

- Models are needed to predict changes in the bioavailability, bioaccumulation, and biodegradation of contaminants for the development of representative biological transport models, based on the numerical models identified above.

Techniques/equipment/instrumentation are desired to measure chemical, physical, and biological parameters in the bank-storage region and the river to parameterize, validate, and verify these models.

Schedule Requirements:

Earliest Date Required: 8/1/99

Latest Date Required: 9/30/05

The Integration Project S&T roadmap (DOE/RL-98-48, 2000) indicates the information that is required over the next 6 years to meet the objectives of the Integration Project. Information associated with reactions and interactions is needed in the FY04 timeframe to meet these objectives.

***Problem Description*:** This need falls under the River Technical Element within the S&T Endeavor. The River Technical Element is intended to support and provide information necessary for an assessment of the effects of Hanford-derived materials and contaminants on the Columbia River environment, river-dependent life, and users of river resources. The objectives of the river technical element are to provide relevant and meaningful information to support remedial decisions and subsequent risk and system assessments, to guide ongoing and subsequent environmental surveillance programs, and to focus future iterations of the cumulative river assessment. Meeting the objectives will enhance protection of human health and the environment by providing scientifically defensible knowledge and data and identifying existing and new S&T that will serve as input to DOE's decision-making process for Hanford cleanup.

The scope of this technology need relates to information needs associated with the fate and transport of groundwater-based contamination once it enters the river environment. These include understanding the contaminant characteristics (type, nature, concentration, decay/attenuation qualities) as they relate to the physical and chemical conditions of the river as it enters the Hanford Reach as developed in RL-SS36. Understanding the interactions of the contaminants with the dissolved organic matter, suspended load, and biological systems of the river, as well as the role of bank storage in altering the timing, chemical nature, and concentration of contaminants as they move through the river system are key to accurately predicting the fate of contaminants.

Key topics in this zone include the following:

- Mixing processes within the river
- Geochemical conditions of the water and sediments that affect bioavailability and transport
- Life history descriptions and parameters for key species relative to quantification of exposure
- Food web structure and biological transport parameters for key species and habitats
- Bank storage and physical/chemical transformations within the river bank
- Numerical river flow and sedimentation models that account for the daily-fluctuating hydrograph of the managed river system.

Credible conceptual and numerical models for processes occurring in this zone are crucial to (1) identifying impacts to the river's ecosystem; and (2) quantifying risks to aquatic and human receptors.

Benefit to the Project Baseline of Filling Need: Filling this need will improve the state-of-the-art of river transport modeling to couple biological transport, physical transport, and physical/chemical state of the contaminants. Bank storage will be included as a prolonged

source of contaminant exposure, and both its modulating capacity and ability to diffuse contaminated surface water into the surrounding terrestrial biota will be addressed. These changes will improve decisions regarding impacts downstream from groundwater plumes. Successful completion of these activities is required to meet the objectives of the Integration Project and the related elements of the Paths to Closure.

***Functional Performance Requirements*:** The techniques applied or information that is obtained must provide an accurate understanding of current conditions over time and the ability to assess potential future conditions, near- and long-term. In addition, the evaluation must allow for the differentiation between contaminant contributions from Hanford and other sources (natural and/or anthropogenic). The information obtained must be applicable toward the conceptual models, fate and transport numerical models, and system assessment capabilities that are being developed as part of the Integration Project.

Work Breakdown
Structure (WBS) No. : 1.4.03.4.4 ***TIP No.:*** TIP-0014

Relevant PBS Milestone: PBS-MC-042

***Justification For Need*:**

Technical: There is an insufficient understanding of reactions and interactions of contaminants and sediments at Hanford in terms of quantifying and parameterizing the processes for use in reactive transport modeling and for determining appropriate conceptual models. An understanding of these fundamental processes is needed to predict the fate and transport of contaminants in the river.

Regulatory: Information obtained by addressing this need will provide an improved technical basis for making site regulatory decisions and therefore reduce the uncertainty associated with the basis for these decisions.

Environmental Safety & Health: This need addresses broad sitewide technical issues and, as such, crosscuts multiple applications that each may have specific environmental safety and health issues.

Potential Life-Cycle Cost Savings of Need (in $000s) and Cost Savings Explanation:
The estimated life-cycle cost savings associated with filling this need is $200M. This estimate is based on an assumed savings of 5% of the total Hanford remediation life-cycle cost of >$5B. Estimated savings are due to information and data gained by filling this need that supports decisions for cost effective remediation and long-term stewardship.

Cultural/Stakeholder Concerns: This technology need supports the resolution of cultural and stakeholder concerns as expressed by the CRCIA Team in “Columbia River Comprehensive Impact Assessment, Part II: Requirements for a Columbia River Comprehensive Impact Assessment” (DOE 1998).

Other: None.

Current Baseline Technology: N/A

End-User: Richland Environmental Restoration Project

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References:

Brandt, C.A., C.E. Cushing, W.H. Rickard, N.A. Cadoret, R. Mazaika, and B.L. Tiller. 1993. Biological Uptake of 300-FF-5 Operable Unit Contaminants. WHC-SD-EN-TI-122, Westinghouse Hanford Company, Richland, Washington.

United States Department of Energy. 1998. Columbia River Comprehensive Impact Assessment, Part II; Requirements for a Columbia River Comprehensive Impact Assessment. DOE/RL-96-16. United States Department of Energy, Richland, Washington.

United States Department of Energy. 2000. Groundwater/Vadose Zone Integration Project Science and Technology Summary Description. DOE/RL-98-48, Vol. III, Rev. 1, U.S. Department of Energy, Richland, Washington.